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TEMPERATURE AND SHELF-LIFE STUDIES WITH PRE-PEELED POTATOES[1]

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During recent years some complaints have been received concerning the quality of pre-peeled potatoes. In all cases studied, poor quality was caused by microbial spoilage and apparently related to the lack of adequate refrigeration during preparation and handling. In addition, preliminary observations indicated that pre-peeled potatoes had a much shorter shelf-life than is commonly thought. Studies were undertaken therefore to determine the cooling rates and the shelf-life of commercially packed, pre-peeled potatoes at different temperatures and the effect of hydrocooling upon keeping quality. Observations were also made on changes in pH, sulfite content and microbial populations of aqueous extracts prepared from pre-peeled potatoes stored at different temperatures for various periods.

Materials and Methods

Sulfite-treated pre-peeled potatoes, both whole and in cut strips for French frying, used in these experiments were packed as 30-pound units in bags of two-ply, wet-strength kraft paper with an inner polyethylene liner and were obtained from two commercial plants in New York City during a ten-month period in 1955-1956. The varieties used as whole, peeled potatoes were Green Mountain of unknown origin, Kennebec and Katahdin from Maine and Long Island, and Sebago from North Carolina. Those used for strips were White Rose from California and Washington, Kennebec from Oregon and Long Island, Russet Burbank from Maine and Chippewa from Long Island.

In studying the rate of cooling of 30-pound bags of pre-peeled potatoes in a commercially operated refrigerator, eight test bags were set in different positions among the commercially packed bags on loaded carts. In studies conducted in the laboratory, the bags were on shelves in walk-in refrigerator rooms maintained at 35° and 45°F. Commodity and air temperatures were determined with copper-constantan thermocouples.

In shelf-life studies, 30-pound bags of pre-peeled potatoes stored at 35°, 45° and 70° F. were withdrawn at frequent intervals until spoilage occurred and the color, odor, appearance and flavor of the potatoes recorded. A total of 121 bags was used in eleven tests. Before judging flavor, whole, pre-peeled potatoes were quartered and boiled, while the strips were deep-fried at 375° in corn or cottonseed oil.

Two 70-gallon metal tanks, each containing 40 gallons of a 0.1 to 1.0 per cent solution of sodium bisulfite in water, were used for the hydro-cooling tests. The solution temperatures ranged from 34° to 38° F in the cooling tank and from 67° to 70° in the control tank. Samples of commercially pre-peeled potatoes weighing 10 to 12 pounds were placed in wire mesh baskets and immersed with shaking for 1 or 5 minutes. Following immersion, the potatoes were bagged and stored at 45°.

[1]Accepted for publication May 31, 1957.

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Aqueous extracts were prepared from 10 whole potatoes and from either 50 or 100 cut strips and analyzed for sulfite content, hydrogen ion concentration (pH), and microbial condition. Whole potato samples averaged about 3.7 pounds and the cut strip samples about 1.7 pounds. The potatoes were placed aseptically in 2-gallon, sterilized, glass jars and a volume of sterile tap water equal to four times the weight of whole potatoes or one and one-half times the weight of cut strips was added. The jars were shaken for 10 minutes by a reciprocating shaker having 90 1½-inch strokes per minute. Sulfite content of potato extracts and treating solutions was determined iodimetrically (8) and the hydrogen ion concentration of the extracts with a glass electrode pH meter. The microbial population was determined by plate counts and the findings were correlated with turbidity of the extracts. Turbidimetric readings were made with a Bausch & Lomb Spectronic 20 colorimeter at a wave length of 525 millimicrons.

Results

Rate of Cooling. In a test in a commercially operated cold storage room with an average temperature of approximately 34° F, 24 hours were required for bagged, whole, pre-peeled potatoes to cool from 68° to 45°, and 21 hours for cut strips to cool from 63.5° to 45° (Figure 1). Under controlled laboratory conditions pre-peeled whole potatoes stored at 45° required about 21 hours to cool from 70° to 50°, whereas those stored at 35° required only 10 hours to reach 50° as shown in figure 2. Whole potatoes and cut strips cooled at about the same rate.

Shelf-life. The importance of adequate refrigeration is shown in the results of 11 tests performed over a period of several months to determine the shelf-life of pre-peeled potatoes at different temperatures (Table 1). The shelf-life of whole potatoes was found to be 1 day at 70°, 3 to 5 days at 45°, and 8 to 11 days at 35° F. The shelf-life of cut strips was less than 1 full day to 2 days at 70°, 4 to 10 days at 45°, and 9 to 13 days at 35°. Strips from Plant A had a longer shelf-life at all three temperatures than those from Plant B. This doubtless resulted from the fact that the strips at Plant A were hydrocooled prior to bagging. In Plant B they were not, with the result that the strips from Plant A were considerably cooler at the time of bagging. Although the pre-peeled whole tubers from Plant A were about 6 to 10 degrees cooler than those from Plant B, the pulp temperatures of the former were above 70° and no increase in shelf-life was observed.

Microbial spoilage resulting in offensive odors and off-flavors was found to be the factor determining the shelf-life of pre-peeled potatoes. Darkening was no problem with the sulfited potatoes used in these tests. Usually potatoes with bad odors also had off-flavors when cooked but in some instances, pre-peeled potatoes without offensive odors after 10 days of storage at 35° F were unpalatable when cooked.

Hydrocooling Tests. In three laboratory trials hydrocooling cut strips for 1 minute reduced the temperature an average of 24.8 degrees whereas a 5-minute dip reduced it 36.6 degrees (Table 2). Hydrocooling resulted in an increase in shelf-life of 2 to 3 days when the potatoes were stored at 45° F. In 2 of the 3 hydrocooled lots, the strips dipped for 5 minutes had one more day of shelf-life than did those dipped 1 minute. This additional

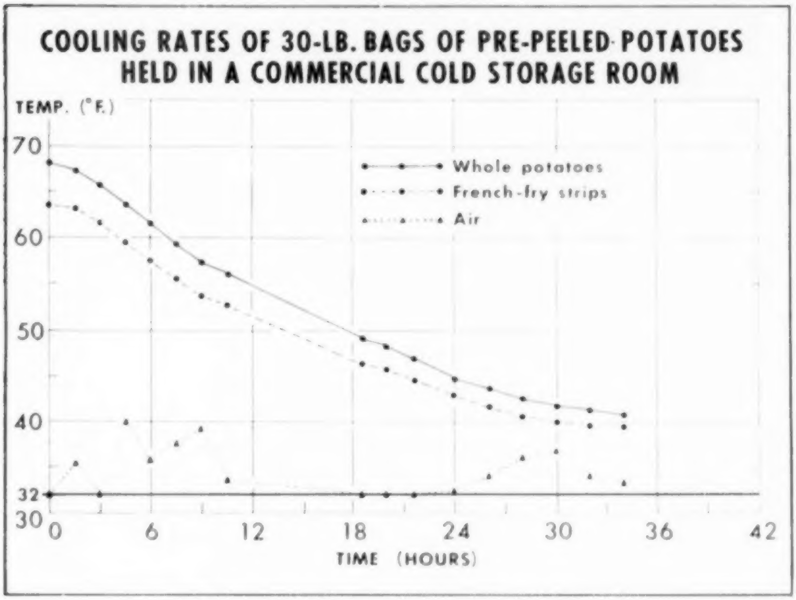

FIGURE 1.—Cooling rate in commercial storage.

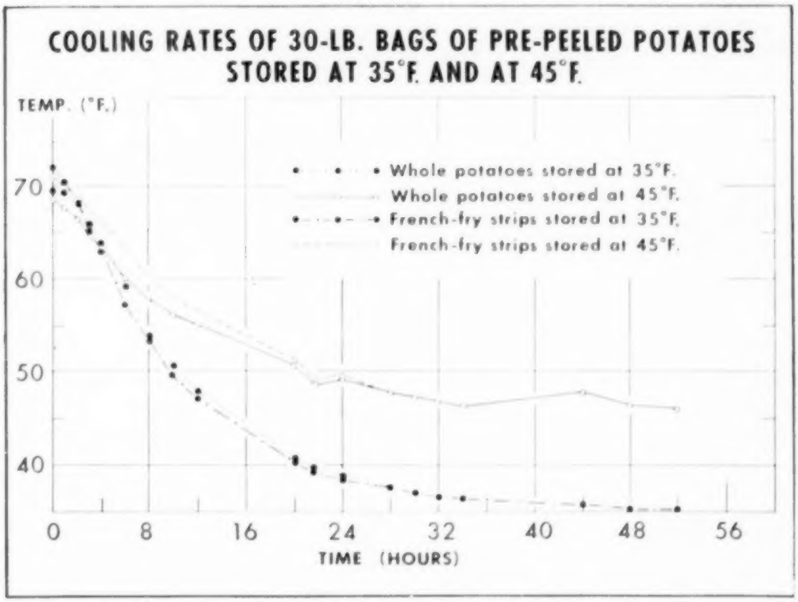

FIGURE 2.—Cooling rate at 35° and 45° F.

TABLE 1.—*Shelf-life of 30-pound bags of commercially pre-peeled potatoes stored at 70°, 45°, and 35°F.*

Plant	Type of Potato	Pulp Temperature[1]		Shelf-life (Days at Storage Temperature Indicated)		
		Initial (°F.)	Final (°F.)	70°F.	45°F.	35°F.
A	Whole	54.0	74.1	1	..	11
	Do	—		1	4	8
	Do	70.5	71.8	1	4	9
B	Whole	67.2	80.5	1	3	9
	Do	71.4	81.9	..	5	..
A	Cut strips	54.0	54.5	1	..	11
	Do	72.7	60.0	1	10	13
	Do	—	46.5	2	..	..
B	Cut strips	65.7	78.0	1	5	9
	Do	70.8	79.2	<1	4	9
	Do	—	78.5	<1	4	..

[1]Initial pulp temperatures taken at the time whole, unpeeled tubers were dumped on the belt, and final temperatures were taken just prior to bagging of the pre-peeled potatoes. Bags of potatoes were placed in the laboratory walk-in refrigerators usually within 1 to 2 hours after preparation. All potatoes were lye-peeled.

TABLE 2.—*Effect of hydrocooling upon the pulp temperature and shelf-life of bagged, commercially pre-peeled potatoes.*

Test	Type of Potato[1]	Number of Bags[2]	Water Temperature (°F.)[3]	Immersion Time (Min.)	Initial Pulp Temperature (°F.)	Final Pulp Temperature (°F.)	Temperature Reduction (°F.)	Shelf-life at 45°F. (Days)
1	Cut strip	4	34-35	1	72.7	49.3	23.4	7[4]
		4	34-35	5	72.7	36.5	36.2	7[4]
		4	68-70	1	72.5	71.7	0.8	4
		4	68-70	5	72.5	71.7	0.8	4
2	Cut strip	5	35-36	1	76.0	49.5	26.5	7
		5	35-36	5	76.0	36.8	39.2	8
		5	69	1	75.7	70.6	5.1	5
		5	69	5	75.7	69.0	6.7	6
3	Cut strip	5	36-37	1	71.2	46.7	24.5	7
		5	36-37	5	71.2	36.8	34.4	8
		5	69	1	71.3	70.3	1.0	4
		5	69	5	71.3	69.0	2.3	5
4	Whole	5	36-38	1	68.0	64.6	3.4	8
		5	36-38	5	68.0	57.0	11.0	8
		5	67-68	1	68.7	68.5	0.2	7
		5	67-68	5	68.7	68.2	0.5	7

[1]Varieties used: Test 1, 2—White Rose (California); 3—Kennebec (Oregon); 4—Sebago (North Carolina).
[2]Bags weighed about 10 pounds in tests 1, 2, 3, and 11-12 pounds in test 4.
[3]Concentration of sodium bisulfite in water: Test 1—0.1 per cent; 2, 3—0.4 per cent; 4—1.0 per cent.
[4]Test terminated at the end of 7 days.

day of shelf-life, however, may have resulted from the increased exposure to the treating solution rather than to the greater temperature drop, as the same result was observed in corresponding non-hydrocooled lots.

In the one test where pre-peeled whole potatoes were hydrocooled, 1-minute and 5-minute dips resulted in temperature reductions of 3.4° and 11.0°F, respectively. The hydrocooling prolonged the shelf-life of these potatoes at 45° by only 1 day. There was no apparent difference in the shelf-life of whole potatoes hydrocooled for 1 minute or for 5 minutes (Table 2).

Effect of Storage Temperature upon Microbial Populations. The results of the determinations of microbial populations in extracts from pre-peeled potatoes are shown in table 3. Eleven determinations, within 2 to 3 hours from the time of commercial preparation, showed an average of about 16,800 microorganisms per milliliter of potato extract, with a range from 6,000 to 51,000. At 70°F the development of microorganisms was very rapid. Microbial growth was substantially slower at 45° and even slower at 35°. Generally, the populations of microorganisms were higher on cut strips from Plant B than on those from Plant A. In addition, shelf-life was usually shorter in Plant B (Table 1).

Plate cultures from extracts of pre-peeled potatoes yielded a mixed flora consisting of non-sporulating Gram-negative and Gram-positive bacterial rods and cocci, spore-forming bacilli, various yeasts and occasionally some molds. No attempt was made to identify the organisms or to determine which ones were primarily responsible for spoilage.

Sulfite and pH Changes in Storage. During the course of the storage experiments more than 120 sulfite determinations of potato extracts were made. Ten of these were made on the day the pre-peeled potatoes were prepared. These averaged 76 p.p.m. sulfite (range 40 to 170) for whole potatoes and 66 p.p.m. (range 35 to 93) for cut strips as shown in table 4. The sulfite content decreased with length of storage; the rate of destruction at 70°F was very rapid. The sulfite content of spoiled potatoes was almost always very low (less than 10 p.p.m.).

The pH readings of potato extracts from freshly prepared potatoes usually ranged from 6.1 to 6.5. During storage at various temperatures the readings ranged from 5.0 to 6.7, the majority being between 6.2 and 6.5. The results of the more than 200 pH readings are not shown, inasmuch as there was no apparent relation between pH and the duration and temperature of storage or spoilage of pre-peeled potatoes.

Discussion

The commercially packed potatoes used in these experiments were obtained from two plants where lye-peeling was employed. Several descriptions of the operation of potato pre-peeling plants have appeared in the literature (6,7,9,10) as well as studies of the economic aspects of the pre-peeling industry (2,3). In addition, reports and patents have been published on the use of various chemical treating solutions to prevent discoloration of pre-peeled potatoes (1,4,8,9), on the use of chemicals to inhibit spoilage (1), and on the rates of cooling of pre-peeled potatoes (5).

The use of hot lye solutions to peel potatoes is chiefly responsible for their high pulp temperatures on the preparation line. Unless effective steps

TABLE 3.—*Microbial populations in extracts from pre-peeled potatoes stored at 70°, 45°, and 35°F for various periods.*

Storage Temperature and Period in Storage	Whole Potato Extracts		Cut Strip Extracts	
	Plant A Microorganisms (10^6 Per Ml.)[1]	Plant B Microorganisms (10^6 Per Ml.)[1]	Plant A Microorganisms (10^6 Per Ml.)[1]	Plant B Microorganisms (10^6 Per Ml.)[1]
Check (unstored)[2]	.045, .009, .051	.007, .006	.012, .006, .007	.007, .01, .025
70°F.				
1 day	3.4, 3.8	23.4	4.1, 1.1	2.4, 16.2, 24.0
2 days	18.0, 14.7, 8.8	50.0	6.7, 7.0, 2.7	18.2, 20.4, 33.5
3 "	29.5, 18.0, 30.2	53.8	10.6, 7.0	17.2
4	134.0	....	78.0	....
45°F.				
3 days	0.3	1.9, 0.1	....	0.5, 2.8
4 "	0.3	6.5, 0.9	....	1.12, 4.6, 1.9
5 "	1.3	0.1	1.9	3.4, 6.3, 2.4
6 "	16.7, 3.3	4.7	....	0.9
7 "	24.4, 17.3	16.0, 6.3	3.4	7.7, 13.7, 12.7, 10.1, 3.1
8 "	24.4, 5.5	26.6, 13.0	3.1	34.2, 17.5, 6.0
9 "	50.0	162.0, 11.6	5.0	13.2
10 "	55.3	40.3	4.7	....
11 "	....	....	7.3	....
35°F.				
3 days	....	2.5	....	0.1
4 "	0.088	2.5	0.02	0.1
5 "	....	....	....	1.9
6 "	1.7, 0.1	....	0.1	....
7 "	0.134	0.7	0.037	0.5
8 "	2.9, 0.56	....	....	1.5
9 "	0.9	1.62	1.5	0.1, 1.9
10 "	3.7, 0.3	7.0	....	17.2
11 "	3.1, 87.0	....	0.09, 0.3	4.1, 2.8
12 "	0.7	12.5	1.5	18.7
13 "	44.8, 28.9, 1.1	....	72.0, 2.4	....
14 "	87.0	....	2.9	13.7

[1]Figures based on plate counts and turbidimetric determinations.
[2]Extract made within 2 to 3 hours after the potatoes were prepared.

TABLE 4.—*Sodium bisulfite concentration (p.p.m) in extracts from pre-peeled potatoes stored at 70°, 45°, and 35°F for various periods*

Storage Temperature and Period in Storage	Whole Potatoes: Plant A Sulfite (P.p.m.)	Whole Potatoes: Plant B Sulfite (P.p.m.)	Cut Strips: Plant A Sulfite (P.p.m.)	Cut Strips: Plant B Sulfite (P.p.m.)
Check (Unstored)[1]	52, 170	60, 40, 59	76, 88	35, 36, 93
70°F.				
1 day	14, 17	10	17, 19	6, 6, 15
2 days	5, 11	5	16, 14	5, 7, 9, 10
3 "	<5, <5, 7	<5	18, 6	....
45°F.				
3 days	9	5, 7, 12	....	9, 10
4 "	16	7, 8, 6	....	7, 7, 15
5 "	19	6, 15	21, 14	5, 7, 10
6 "	<5, 8, 7	<5, 10	12	8
7 "	<5, 5	<5, <5, 9	13, 16	<5, <5, <5, 8, 7
8 "	<5, <5	5, 6, 5	7	<5, 5, 5
9 "	<5	5, <5, 10	7, 7	....
10 "	<5	5	11	....
11 "	....	....	<5	<5
12 "	....	....	7	....
35°F.				
3 days	10	9	....	10
4 "	....	8	....	13
5 "	....	....	....	9
6 "	10	....	30	....
7 "	....	16	....	5
8 "	<5, 7	....	....	6
9 "	13, 7	....	11	8, 6
10 "	<5, 14	7	....	5
11 "	5	<5	11	<5, <5
12 "	11	....	12	....
13 "	<5, 7	....	13	<5
14 "	<5	....	7	<5

[1] Extract made within 2 to 3 hours after potatoes were prepared and held at 35°F. until sulfite content was determined later that day.

are taken to cool the pre-peeled potatoes, they will be packed with undesirably high temperatures. Furthermore, the multi-ply bag impedes the removal of heat when the bags are placed under refrigeration. The present tests on the cooling rate indicate quite clearly that under commercial conditions and even under more ideal laboratory conditions bagged, warm potatoes cool rather slowly. The longer the time required to bring the commodity temperature down to a satisfactory storage level, the greater the opportunity afforded spoilage organisms to develop.

In the series of tests reported, pre-peeled potatoes were obtained from two different plants. No strict comparison between the quality of the pre-peeled potatoes from the two plants was made because of the many differences as regards the source of potatoes, time and temperature of

lye-peeling, immersion time and strength of the sulfite treating solutions, and so forth. However the cut strips obtained from the plant that hydrocooled its pre-peeled potatoes in a refrigerated treating solution just prior to bagging had a consistently longer shelf-life than the cut strips from the other one.

In the laboratory, hydrocooling of cut strips even for 1 minute resulted in a marked drop in pulp temperatures and an increase in shelf-life. In view of these findings and the longer shelf-life noted with the commercially hydrocooled product, it can be recommended that a refrigerated treating solution be used for pre-peeled cut strips. Ideally, the temperature of the hydrocooling solution should be approximately 32° to 34°F and the immersion time at least 1 minute. Probably a combination which reduced pulp temperatures of cut strips below 50° would justify the added expense of hydrocooling. Although some benefit seemed to accrue from the hydrocooling of whole, pre-peeled potatoes, this might not be economically feasible in view of the time which would be required to effect a substantial reduction in the pulp temperatures of whole potatoes.

Microbial spoilage of pre-peeled potatoes undoubtedly results from the removal of the potato skin that serves as a natural barrier to spoilage organisms, the presence of free water and high humidity within the multiply, heat-transfer-resistant bags, and high pulp temperatures resulting from inadequate refrigeration. Market observations over a period of several years and the results of the present tests show that microbial spoilage causing off-odors and off-flavors was the principal factor limiting the shelf-life of pre-peeled potatoes. This emphasizes the need for prompt and adequate refrigeration of pre-peeled potatoes, daily or frequent deliveries in insulated, pre-cooled, or preferably refrigerated trucks, and prompt utilization by the purchasers.

SUMMARY

Cooling of 30-pound bags of pre-peeled and sulfited whole potatoes or cut strips was found to be slow under commercial and laboratory conditions.

The shelf-life of whole, pre-peeled potatoes was found to be about 1 day at 70°, 3 to 5 days at 45°, and 8 to 11 days at 35°F. For cut strips the shelf-life was less than 1 full day to 2 days at 70°, 4 to 10 days at 45°, and 9 to 13 days at 35°.

Hydrocooling of cut strips prior to bagging was found to effect marked reductions in pulp temperatures and to increase the shelf-life. Whole, pre-peeled potatoes were benefited less by hydrocooling.

Sulfite concentrations of potato extracts dropped rapidly during storage of pre-peeled potatoes at high temperatures. Very low amounts of sulfite (less than 10 p.p.m.) were found in extracts prepared from potatoes at or near the end of their shelf-life. There was no apparent relation between the changes in pH of the potato extracts and the quality of the pre-peeled potatoes during storage.

Microbial spoilage causing off-odors and off-flavors was the principal factor in determining the shelf-life of commercially packed, pre-peeled potatoes.

Literature Cited

1. Anderson, E. E., W. B. Esselen, and C. R. Fellers. 1954. Factors affecting the quality of pre-peeled potatoes. Food Tech. 8: 569-573.
2. Garrott, W. N. 1955. The commercial potato peeling industry. U. S. Dept. Agr., Agr. Mktg. Serv., Res. Rpt. 105.
3. ————, and A. E. Mercker. 1954. The commercial potato peeling industry. In, Abstracts of Papers, Sixth National Potato Utilization Conference, Ithaca, N. Y., Pp. 22-28.
4. Greig, W. S. 1954. Some factors affecting the quality of pre-peeled potatoes. In, Abstracts of Papers, Sixth National Potato Utilization Conference, Ithaca, N. Y., Pp. 29-30.
5. Harrington, W. O., P. C. Mayer, R. L. Olson, W. R. Mullins, and A. L. Potter, Jr. 1956. Observations on pre-peeling of potatoes. Food Tech. 10: 347-351.
6. Havighorst, C. R. 1948. Pre-peeled potatoes from mechanized line. Food Indus. 20: 999-1001, 1108-1110.
7. Mazzola, L. C. 1946. Potato peeling methods analyzed and appraised. Food Indus. 18(11): 1708-1709, 1832, 1834, 1836; (12): 1874-1876, 1980, 1982.
8. Mullins, W.R., R. L. Olson, and R. H. Treadway. 1953. Control of discoloration of peeled white potatoes and methods for analysis of treating solutions. U. S. Dept. Agr., Bur. Agr. and Indust. Chem., AIC-360, 8 pp.
9. Olson, R. L. and R. H. Treadway. 1949. Pre-peeled potatoes for commercial use. U. S. Dept. Agr., Bur. Agr. and Indust. Chem., AIC-246, 14 pp. Also AIC-246, Supp. 1, 1 p.
10. Ziemba, J. V. 1954. Potato peeling spurts on continuous, company-built production line. Food Eng. 26: 92, 216-222.

CARBOHYDRATE COMPOSITION OF POTATOES. PECTIN CONTENT[1]

A. L. POTTER AND E. A. MCCOMB[2]

Potatoes are known to vary considerably in texture after they are cooked. Some varieties appear translucent and feel wet and pasty on the tongue and are characterized as soggy or waxy. Others glisten and feel granular and dry on the tongue and are considered mealy. There is also a variation in texture of cooked potatoes within a given variety.

When boiled, mealy potatoes slough more rapidly than soggy ones and this difference is due to the ease of separation of the potato tissue cells (7, 10). Since pectic substances are found in cell walls and in intercellular materials in the middle lamella, it may then be surmised that differences between soggy and mealy potatoes are in part due to difference in quantity and quality of the pectic substances which are involved in the architecture of plant cell walls.

The many attempts to relate potato texture to pectin content have not shown any obvious relationships (1, 4, 6, 9, 10). Recently Bettleheim and Sterling (2, 3, 8), studying factors associated with potato texture, isolated water-, Calgon[3], and hydrochloric acid-soluble fractions and determined the quantity of pectin in the potatoes from the analyses of the fractions isolated. No direct relationship was found between the various fractions of pectic substances and potato texture. However, they found by evaluation of partial and multiple correlation coefficients that the starch content and various pectic characteristics (calcium content, intrinsic viscosity of the Calgon-soluble fraction, and total pectinate) were interrelated with texture. Their total pectin was the sum of the anhydrouronic acid contents of the three fractions isolated and therefore may not be a measure of the total pectin in the tubers due to the possibility of incomplete extraction of all of the pectin present.

Since methods for determining pectin used by some earlier workers are now known to be inadequate, it is desirable to have data from potatoes obtained by pectin methods developed in recent years. This investigation was undertaken in order to determine the pectin content of potatoes by a method which is known to solubilize pectic substances in plant tissues and give a measure of the total pectin as anhydrouronic acid. McCready and McComb (5) have developed such a method for fruits and their procedure was investigated for use in the determination of pectin in potato tubers.

The pectin content was determined in individual potatoes with different specific gravities in the same lots and in potatoes of different varieties from different lots. Russet Burbank potatoes grown in three growing areas in California from the same seed stock were analyzed. Subjective appraisal for texture of cooked potatoes was compared with their pectin content.

[1]Accepted for publication June 7, 1957.
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[3]Mention of manufacturers or trade names does not imply endorsement by the U. S. Department of Agriculture over others of a similar nature not mentioned.

Experimental

Method. One hundred to 200 gm. of peeled, diced, or sliced potato are mixed with an equal weight of water and 50 mg. of sodium bisulfite to prevent enzymatic browning in an electrical blender run at high speed for 5 minutes. Fifteen to 20 gm. samples of the mixture are pipetted (using a pipette with the tip removed and the blender set at slow speed) into a tarred 250-ml. beaker and reweighed. About 200 ml. of 95 per cent ethyl alcohol is mixed with the sample and the mixture is allowed to stand at least one hour. The mixture is filtered and the filtrate discarded. The pulp is washed twice with 75 per cent ethyl alcohol and then suspended in 200 ml. of 0.5 per cent Versene[4] (tetrasodium salt of ethylene diamine tetra-acetic acid) solution. The pH is adjusted to 11.5 with 0.1*N* sodium hydroxide and the mixture allowed to stand for 30 minutes with occasional stirring. The pH is adjusted to 5.0 to 5.5 with glacial acetic acid, and 10 mg. of pectinase (10 ml. of a freshly prepared suspension of 1 mg. of Pectinol 100D[5] per ml.) are added. A few mg. of phenylmercuric nitrate is added as a preservative and the mixture stirred and then allowed to stand overnight. The mixture is diluted to 250 ml., mixed, and filtered through folded filter paper. The first few ml. of filtrate are discarded. Twenty-five ml. of the filtrate are diluted to 200 ml. and the anhydrouronic acid is determined in 2 ml. as described by McCready and McComb (5).

Variables in the Method Studied

Size of Sample. In order to obtain a representative sample of potato tubers it was necessary to blend 100 to 200 grams of diced or sliced potatoes and take aliquots of the slurry for analysis. Blending the potato tissue without water was not practical, because the heat generated during blending gelatinized the starch. Increasing the potato-water ratio from 1:15 to 1:1 during blending and increasing the time of blending from 5 to 10 minutes results in no change in anhydrouronic acid content.

Quantity of Pectinase. It was found that the enzyme preparation Pectinol 100D contains substances which develop color with carbazole. Under the conditions of the colorimetric procedure described it was determined that the amount of color produced was directly proportional to the milligrams of enzyme used in the range of 0 to 8 milligrams of pectinase per ml. and that 2 milligrams of Pecinol 100D per ml. gave a color equivalent to 5 micrograms of anhydrouronic acid per ml. In the method for the analysis of fruits, which have a high pectin content as compared with potatoes, the ratio, of uronic acid to pectinase is high, and therefore the contribution of the color produced from the enzyme preparation is insignificant. Considering the relatively low pectin content of potatoes and the possible effect of the quantity of enzyme used, a study was made to determine the quantity of Pectinol 100D necessary to extract the pectic substances. Zero to 100 mg. of Pectinol 100D were used in the procedure and it was found that pectinase is necessary and that 5 to 10 mg. quantities are sufficient to extract all the pectic materials. The quantity of enzyme

[4]Obtained from Bersworth Chemical Co., Framingham, Mass. under the trade name Versene, regular.
[5]Obtained from Rohm and Haas Co., Philadelphia, Pa.

recommended for the extraction of pectin in fruits (5), when used for the determination of pectin in potatoes, gave values about 10 per cent higher than the actual quantity present unless a correction was made for the color produced by the enzyme preparation. It is possible that different enzyme preparations would give different color values, and therefore it may be necessary to check these before using.

Effect of Starch. Approximately 80 per cent of the soilds in potatoes is starch. If during the extraction and enzymatic hyrolysis of the pectic substances some of the starch is dissolved, erroneous results may be obtained due to interference of sugars in the carbazole method. To check this possibility, samples were heated with water to gelatinize the starch. The starch was hydrolyzed with salivary amylase and then 2 volumes of 95 per cent ethyl alcohol were added. The mixture was filtered, the residue washed with 75 per cent ethyl alcohol, and the anhydrouronic acid was determined in the residue. The results were compared with results from samples treated by the regular procedure. No differences in pectin content were found and it was concluded that the starch in potatoes does not interfere in the method. It is probably necessary, however, to remove the starch if the pectin content is being determined on cooked or processed potatoes, because gelatinized starch does interfere.

Results

The total solids, crude fiber, and pectin contents of individual tubers having different specific gravities and taken from the same lots of potatoes are summarized in table 1. These data show that pectin content is independent of the specific gravity of the tubers. The pectin content was about the same in potatoes from the same lot of high or low specific gravity. Also, the data indicate that crude fiber content is independent of specific gravity and the total solids are as expected; *i. e.*, high-specific-gravity-potatoes have a high solids content.

In addition to individual potatoes from the same lot, the pectin contents of potatoes of three lots of two varieties were determined. These data are presented in table 2 and show that little difference is found in each variety. However, in table 3 potatoes grown from the same seed material in different growing areas in California had somewhat different pectin contents, which varied from 0.21 to 0.33 per cent.

Russet Burbank potatoes grown in 3 areas in California (Davis, Hollister, and Tulelake) having different pectin contents and about the same specific gravities were cooked and subjectively appraised for texture. The data in table 4 do not show a correlation of texture with pectin content.

Summary

A colorimetric procedure for extracting and determining pectin in fruits was modified for analysis of potatoes. Pectin contents of different varieties and lots were determined. Results show that there was little difference in the pectin content of tubers from the varieties studied. Pectin content was independent of the specific gravity of the tubers and varied with different growing locations and cultural conditions. There was no correlation between subjective appraisal for texture and the pectin content of the potatoes.

TABLE 1.—*Pectin content and specific gravity of potato tubers.*

Variety	Specific Gravity	Total Solids Per cent	Crude Fiber Per cent	Pectin as A.U.A. Per cent
Russet Burbank, Idaho	1.081	22.0	0.38	0.28
	1.085	22.8	0.33	0.28
	1.088	23.1	0.35	0.28
	1.093	24.6	0.36	0.26
	1.095	25.0	0.38	0.29
	1.101	26.0	0.37	0.28
White Rose	1.068	17.8	0.33	0.23
	1.072	18.8	0.33	0.25
	1.074	18.8	0.27	0.23
	1.079	20.8	0.34	0.24
	1.081	20.4	0.35	0.26
	1.085	21.8	0.33	0.25
Katahdin, Maine	1.074	19.3	0.39	0.24
	1.076	19.1	0.41	0.23
	1.078	20.8	0.41	0.27
	1.083	21.0	0.35	0.22
	1.086	21.8	0.39	0.25
	1.092	23.2	0.36	0.23

TABLE 2.—*Pectin content of different lots of potatoes.*

Variety	Pectin as A.U.A. Per cent
Russet Burbank, Idaho	0.28
Russet Burbank, Oregon	0.28
Russet Burbank, Idaho Experiment Station	0.25
White Rose, Kern Co., Calif. (1954)	0.25
White Rose, Kern Co., Calif. (1955)	0.24
White Rose, Fresno, Calif. (1954)	0.26

TABLE 3.—*Pectin content of Russet Burbank potatoes grown in different growing areas in California from the same seed material.*

Growing Area	Soil Type	Harvest Date	Pectin as A.U.A. Per cent
Tulelake	Muck	9/6/55	0.25
Tulelake	Muck	10/11/55	0.21
Tulelake	Intermediate	9/6/55	0.29
Tulelake	Intermediate	10/10/55	0.22
Tulelake	Intermediate	11/9/55	0.22
Tulelake	Sand	9/27/55	0.26
Holllster	Sand	10/3/55	0.27
Davis	Sand	10/12/55	0.33

TABLE 4.—*Comparison of subjective appraisal for texture with pectin content of Russet Burbank potatoes.*

Area Grown	Specific Gravity	Pectin as A.U.A. Per cent	Average Texture Ranks[1]	
			Mouth[2]	Plate[3]
Davis	1.076-1.081	0.33	1.8	1.8
Hollister	1.076-1.078	0.27	2.5	2.6
Tulelake	1.077-1.081	0.21	1.7	1.6

[1]Ten judges, 2 replications
1=most mealy, 3=least mealy
[2]Feel in mouth
[3]Mashing with a fork on a plate

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LITERATURE CITED

1. Barmore, M. A. 1937. Potato mealiness and changes in softness on cooking. Food Res. 2: 377.
2. Bettelheim, F. A., and C. Sterling. 1955. Factors associated with potato texture. I. Specific gravity and starch content. Food Res. 20: 71.
3. ————, and ————. 1955. Factors associated with potato texture. II. Pectic substances. Food Res. 20: 118.
4. Freeman, M. E., and W. S. Ritchie. 1940. Pectins and the texture of cooked potatoes. Food Res. 5: 167.
5. McCready, R. M., and E. A. McComb. 1952. Extraction and determination of total pectic materials in fruits. Anal Chem. 24: 1986.
6. Pyke, W. E., ad G. Johnson. 1940. The relation of the calcium ion to the sloughing of potatoes. Amer Potato Jour. 17: 1.
7. Reeve, R. M. 1954. Histological survey of conditions influencing texture in potatoes. I. Effects of heat treatments on structure. Food Res. 19: 323.
8. Sterling, C., and F. A. Bettelheim. 1955. Factors associated with potato texture. III. Physical attributes and general conclusions. Food Res. 20: 130.
9. Sweetman, M. D. 1936. Factors affecting the cooking qualities of potatoes. Maine Agr. Exp. Sta. Bull., 383.
10. Whittenberger, R. S., and G. C. Nutting. 1950. Observations on sloughing of potatoes. Food Res. 15: 331.

PROBLEMS INVOLVED IN PRETESTING THE TENDENCY OF POTATOES TO DARKEN AFTER COOKING[1]

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The cooking quality of potatoes is a question on which the housewife needs information at the time of purchase. Yet, only exterior characteristics are considered in assigning grades. So, a housewife often is disappointed in obtaining potatoes which do not "cook white." Much information is needed in order to formulate a reliable and practical method of assessing the color tendencies of potatoes as a test prior to retail sale. The measurement of darkening which occurs upon exposure of cooked potatoes to air involves certain factors which are inherent in any color determination and others which are more specific to this discoloration. The discoloration is usually more prominent at the stem end, but varies from a diffuse blue gray to dark gray or black area involving most of the tuber. It is distinct from the blackness around the eyes which develops during cooking and from the blackening which follows the red color on the surface of raw potatoes when exposed to the air.

The method of evaluation which seems most feasible to the authors is to cook a sample of the potatoes and expose them to the air to develop the discoloration to be measured. Such a procedure might be used by an inspector if it were carefully standardized in terms of factors which are known to influence the color. The conditions which need to be considered are the kind and the amount of water used, the time of cooking and exposure to air, and the temperature and period of storage of the potatoes prior to the test. In addition, there is the problem of a subjective evaluation or whether some color instrument can be used. The characteristic, uneven distribution of the blue-black discoloration, must be taken into consideration in preparing samples for any color instrument. There is also the question as to whether such color reading is correlated to the psychological response of the consumer. If, on the other hand, a group of observers rate the color or discoloration, there is also the question of rating of the psychological response of the panel on any particular day and the question whether they react as the purchasing consumer would do. Certain phases of the problem of assessing the quality of color have been studied in these series of experiments.

PROCEDURE

With conditions carefully controlled, comparisons were made, often on paired halves, of factors which might occur to influence the validity of the test. Three studies were therefore, conducted. Study 1 was concerned with hydrogen ion concentration and degree of hardness of the cooking water on the blackening of potatoes; Study 2 dealt with the establishment of the standard for grading the color of potatoes; and in Study 3, comparisons were made of potatoes which were held in cold storage until tested,

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and other tubers from the same lots which were kept at room temperature for one or three weeks before the test.

The tubers used for the tests were of medium size and as free from defects as possible and were selected at random from the sample. The potatoes were scrubbed with a vegetable brush under running water, and then peeled with a hand potato peeler. A special effort was made to go over a given area of the potato only once so as to remove an equal depth of the cortical layer in all cases. Eyes and blemishes were removed with the tip of a paring knife. The tuber was then laid on a cutting board flat side down and cut longitudinally so that one half of the top and one half of the bottom were in each section. This method of cutting also permitted the inclusion of one half of the stem end and one half of the bud end in each section. The tuber halves were divided into their respective combinations, coded, and a record was made of their identity. The potato halves in each combination were weighed, placed in aluminum sauce pans with tightly fitting lids, and boiling water, equal to their weight, was added.

During boiling, the gas flames were so adjusted that only enough heat was evolved to keep the potatoes at the boiling temperature. The degree of doneness was determined by piercing the sections with a fork, the end point being taken when the fork could enter the tissue easily but the section would stay intact. The excess water was drained immediately from the cooked tuber halves, which were then put out for display.

The sections were numbered consecutively and were placed in a random fashion, cut side down on white, eight inch, semi-vitrous China plates. The potatoes were exposed to the air one half hour from the time of draining before the judging was begun and all judging was completed within two hours. The number of tuber halves for a single days judging varied from 20 to 48.

The room in which the tuber halves were displayed was neutral, light gray in color. The window exposures were to the north and east. If artificial lighting was used, it consisted of a combination of diffuse, incandescent, and fluorescent types. The artificial lights were at ceiling height directly over the display, which was on a neutral, light gray table.

The judging panel consisted of five to nine individuals, graduate students and instructors in Home Economics. The scoring was done independently and without discussion of any kind. When evaluating the color of the tuber halves, a range of 1 to 10 points was used; a score of 10 or 9 was a tuber half of nearly perfect whiteness, a score of 7 or above was considered acceptable for table service, a score below 7 indicated that the tuber half was considered unacceptable on the basis of after cooking discoloration.

When the scoring was completed, the paired tuber halves were matched by fitting the cut sides together so that the data could be correctly identified and tabulated. The scores of the judges were expressed in the form of a series of histograms to obtain the distribution of the scores, and to note the differences between the scores for the paired halves.

In Study 1,—longitudinal halves of tubers,—each containing one-half of the top and one-half of the bottom of the tuber were cooked as follows: (1) one-half in tap water, pH of 7.5 with 24 grains hardness, and its paired half in deionized water, pH of 7.0 with 1 grain hardness; (2) both paired halves in tap water; and (3) both paired halves in deionized

water. The potatoes for this study were selected from eight samples to give the widest possible range of discoloration found in potatoes after cooking. The potatoes were purchased in retail stores, the retailer supplying the name of the variety from his invoices or from the package labels. The varieties tested were Wisconsin Russet Burbank, Chippewa, Russet Sebago, Russet Rural, Red Pontiac and Irish Cobbler. There were also included in these tests some California "Long Whites" and Michigan "Chippewas" for which the retailer did not have the variety name from the package.

In Study 2, investigation was made of an idea which we hoped might help to produce more consistent evaluation of the dark color. A set of pictures of a wide range of dark discoloration was assembled and given to judges to aid in doing more consistent scoring.

For the photographs, tuber halves were selected from the display as representative of the range from white to gray or black discoloration on different testing days. These halves were taken to the University of Wisconsin Photographic Laboratory where the pictures were taken. The lighting for the pictures was two photo flood number two lights on two sides of the selected tuber halves at a distance of seven feet. The film used was Super XX, speed three seconds; F-32. The negatives were in the developer, D-11, five minutes.

The pictures of the potato halves were printed life size both as glossy prints and on low gloss paper. From these pictures six were chosen and mounted with equal spacing for a standard of comparison. After experience with them in this arrangement, a four choice arrangement was decided upon. Some of the pictures illustrated tuber halves with an equal amount of graying over the entire surface and others had definite heavy dark streaks with much whiter areas. Under the four choice scheme, both types were given approximately the same color score.

Fifty tubers of a wide range of discoloration were used to determine the effectiveness of the pictures. These potatoes were scored in the conventional method of Study 1 and were scored again with the aid of a set of pictures. The key and the order of arrangement were changed between the time of the judgings. The set of pictures were labeled by letters and the scorers simply indicated the letter of the picture nearest in color to that of the test sample. These letters were assigned scores of one to ten by three persons of wide experience in potato color evaluation. Such a base is, therefore, quite autocratically assigned, yet was uniform for the transfer of all the letter scores to numerical scores and has considerable merit in making comparisons.

Study 3 was conducted on six varieties, Katahdin, Russet Burbank, La Soda, Ontario, Chippewa, Russet Sebago grown in four areas in the state of Wisconsin. Two of these areas are in the north central and sandy soil region and the other two from the southern or muck soil region of the state. During the course of the experiment, samples of the potatoes were removed from cold storage and held at room temperature for one or three weeks. For comparison, some of the potatoes were cooked immediately on removal from storage, 36 tubers being used for each treatment.

A judging panel of 9 members scored the tuber halves for color, using the series of black and white pictures from Study 2 as a guide. The

color scores of the judges were averaged to obtain a mean score for each tuber half. The overall mean scores were obtained for the individual samples and treatments or storage periods. The per cent decrease in mean scores from zero week to three weeks was determined. The statistical method of analysis of variance was applied to the data on varieties for each storage period.

RESULTS

Study 5. The Influence of Type of Water on Color Scores. Three combinations of treatments were applied to 290 tubers divided as follows: (1) one half in tap water and its paired half in deionized water, (2) both halves in tap water as compared with both halves in deionized water, (3) and the summation of judgments on halves of tubers cooked in either tap or deionized water. This arrangement was devised to determine if the differences in the hydrogen ion concentration and the hardness of the water had any effect on the amount of discoloration that developed in potatoes after cooking. The paired halves cooked in either tap or deionized water were considered checks on the ability of the judges in scoring potatoes for color. The data are presented in figure 1, the frequency distribution of scores being shown as histograms.

When considering the paired halves, it was found that 51.8 per cent of those in tap water and 50.2 per cent of those in deionized water were scored in the 5 to 7 range, with the score of 6 being the mode. The percentage of the judgments given the score of 6 in this section were amazingly alike for both waters, 20.2 per cent and 20.6 per cent. The percentage of judgments, that were scored 7 or above and thus in the acceptable color range, was 29.2 per cent for tap and 35.0 per cent for deionized water. The average score of the tubers was slightly higher for the halves cooked in deionized water, 5.6 as compared with 5.2.

The percentage of judgments of the tuber halves both of which were cooked in tap water that fell in the 5 through 7 range was 45.5 per cent; the percentage with a score of 6 was 18.6; the percentage with score of 7 or above was 23.4; and the average score was 4.9. Following the same order for the tuber halves both of which were cooked in deionized water, there were in the 5 through 7 range, 54.1 per cent; in score of 6, 22.2 per cent; with the score of 7 or above, 26.0 per cent; with the average score being 5.3.

The average scores on the composite data then were 5.1 for tap and 5.4 for deionized water. The percentages and average scores demonstrate that the hydrogen ion concentration or hardness of tap water had some, but little effect, on the amount of discoloration that developed in potatoes after cooking and exposure to air.

As can be noted from figure 1, Histogram A of the paired halves cooked in tap water, is skewed to the left, indicating that there were more scores in the lower ranges than in the higher. Histogram B, of the paired halves cooked in deionized water, is not skewed appreciably to either side of the central score of 6 but again there were more scores below the acceptable range. Histograms C and D which represent the potatoes of which both halves were cooked in either tap or deionized water are skewed to the left of the score of 6 to a still greater degree. Different tubers were used for these data and they were not paired halves as for

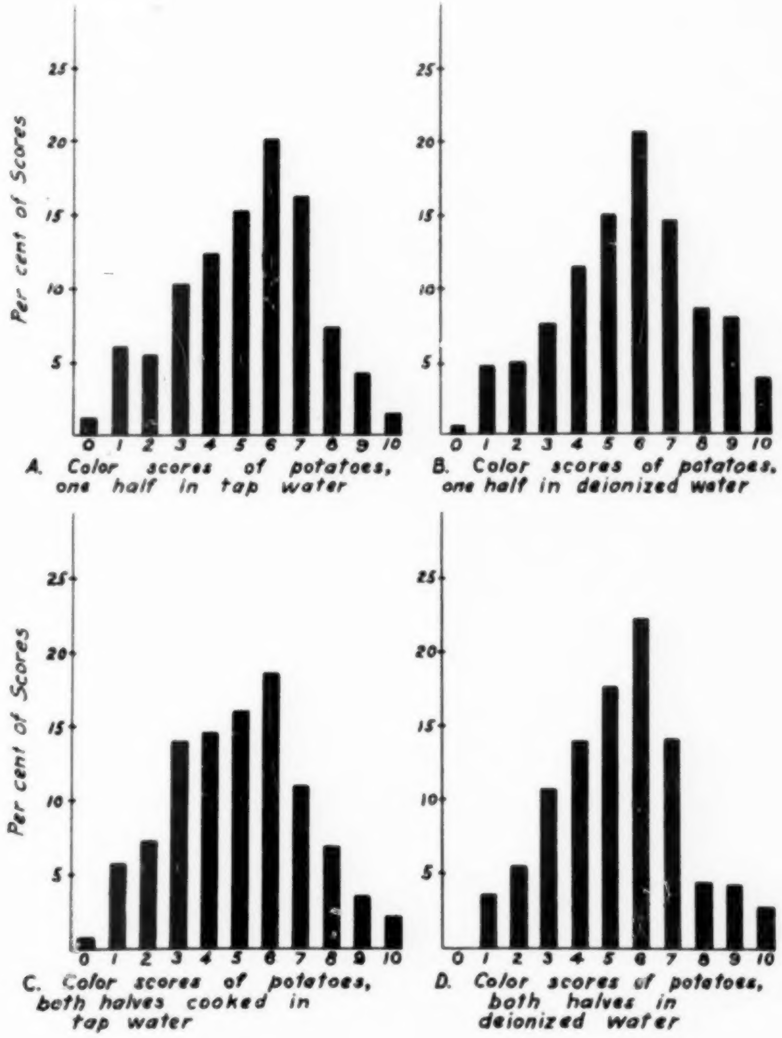

Figure 1. Histograms of judgments according to the type of water and combinations of paired halves

Histograms A and B. There was no difference between the tuber halves, one cooked in tap water and its mate cooked in deionized water in 33.9 per cent of the judgments. Of the halves cooked in deionized water, 45.3 per cent of the judgments scored higher than those cooked in tap water. However, 20.9 per cent of the judgments scored the halves cooked in tap water higher than their mates cooked in deionized water. By subtraction then, only 24.4 per cent of the scores of individual tuber halves were in favor of those cooked in deionized water.

Study 2. The Use of a Set of Pictures to Aid in Color Judgments. From the pictures of 12 tubers of a wide range in discoloration, six were chosen for the comparison set and assigned letters for which the numerical values could be equated. For some of the blackened potatoes, two pictures were used for one letter, one being a less intense, but more uniform color; whereas the other a more intense dark color in a smaller area. The pictures are reproduced as figure 2. They were used for scoring 50 tuber halves by the same judges, the potatoes being scored first in the conventional manner and again with the set of comparison pictures. It was immediately evident that the numerical values assigned to the pictures by the special panel of three workers of long experience in potato research were higher than the mental standards of the regular judging panel. This is shown by the fact that the same potatoes were given an average score of 5.2 with 20.6 per cent of them scored 7 or above when judged as in Study 1, whereas with the pictures and the numerical values assigned to them, the average score was 6.2 with 48 per cent of the tubers with a score of 7 or above. Therefore, there was a difference of opinion as to what degree of darkening was acceptable for serving in a potato somewhat below perfect.

A visual method of studying the scores of the various judges was that of comparing their control charts, a plot in which the position of each judge's score on the scale is compared with the average of all judges' scores for that particular tuber. Of a possible 50 scores (5 judges x 10 tubers) only 6 individual scores were the same as the judges averages or very close to them when the procedure of Study 1 was used. With the aid of the pictures, the judges increased agreement remarkably. There were 24 judgments of 50 essentially the same; and of the 10 tubers, there were 4 on which all judges agreed exactly. Therefore, observant judges reduce their variation greatly, when a standard for comparison is available.

In Study 3, an experiment was conducted on the effect of the previous period of room temperature storage. The influence of the length of conditioning period was assessed by color scores using the set of pictures from Study 2. The analysis of variance of the judges color scores for Study 3 are given in Table 1 as well as the means for variety-samples and storage periods. There were shown highly significant differences between the variety-samples and significant ones for storage periods and interaction between varieties and storage periods. The means showed a great variation in color scores for the various varieties, the grand means varying between 9.21 and 3.53. When one compares the differences between sample means with the statistically computed least significant differences the following comparisons were found to differ significantly: (1) Katahdin variety and all those with lower color scores, except the Russet Burbanks grown at Delavan; (2) Russet Burbanks (Delavan) and all those with lower scores;

FIGURE 2.—A series of tuber halves having a wide range of after-cooking-darkening and the assigned color scores.

TABLE 1.—*Analysis of variance of the color scores of potatoes held at room temperature for different periods of time.*

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Square	F
Variety samples	7	1335.5183	190.7883	85.802**
Storage periods	2	15.4842	7.7421	3.482*
Varieties x storage period	14	64.6279	4.6163	2.076*
Error	72	160.1006	2.2236	
Sub-total	95	1575.7310		
Between tubers	192	129.0125	0.6719	
Between halves of the same potato	96	17.4800	0.1821	
Total	383	1722.2235		

Means for Variety-samples

Storage Period	Katahdin	Russet Burbank (Delavan)	La Soda	Ontario (Racine)	Russet Burbank (Hancock)	Chippewa	Russet Sebago	Ontario (Bryant)	Grand Mean
None	9.36	9.45	7.72	7.32	6.15	5.26	5.28	3.16	6.71
1 Week	9.06	8.84	7.31	7.16	5.56	5.58	5.13	3.41	6.51
3 Weeks	8.87	9.34	6.91	5.58	4.31	5.92	4.81	4.03	6.22
Grand Mean	9.10	9.21	7.32	6.69	5.34	5.59	5.07	3.53	6.48

*Significant
**Highly significant

L.S.D. for varieties at 5 per cent = 0.607
L.S.D. for storage periods at 5 per cent = 0.371 for grand mean; for individual variety mean = 1.051

(3) La Soda and Ontarios from Racine, with all those having lower scores but these two approach, but do not attain a significant difference between themselves; (4) the Russet Burbanks from Hancock, the Russet Sebagos and Chippewas are not significantly different from each other, but each is different from the Ontarios grown at Bryant. There are therefore, among these eight samples, two examples of the same varieties each grown in a different location and both show a statistically significant difference in color scores.

There was in two samples, Ontario (Racine) and Russet Burbank (Hancock) a marked decrease in color scores when the storage period was increased from one to three weeks. These two differences were found to be statistically significant, based upon a comparison of the least significant differences. On the grand means for storage periods, the difference between zero and three weeks was also significant in comparison with the L.S.D. In all probability, the Ontario (Racine) and Russet Burbank (Hancock) account for the major portion of the significance for storage periods and interaction of the whole group of samples.

One may conclude, therefore, that some samples of potatoes may show more discoloration at the time a housewife uses the potatoes than at the time a test was made directly from cold storage. Of these eight samples, four were acceptable and four unacceptable at all periods whereas only one sample was rated good at first and unacceptable after longer room temperature storage. The two samples which had the high scores showed less percentage decline in color scores than any of the borderline samples. If these eight samples are representative, one might expect that this would be a problem of practical importance only in occasional borderline cases.

One further comparison is of interest from table 1, the mean squares of "Between tubers" and of "Between halves of the same potatoes." These were based on the judges' scores assigned to the two halves of 96 potatoes included in duplicate within the groups. The mean squares represent a measure of the variance due to judging technique and is quite low with no significance. The accuracy of the judges and the method of color assessment, therefore, is of the same order as the differences between the two halves of the same tubers.

Discussion

The experience in this laboratory regarding the feasibility of the discoloration of potato cores in alcohol has been rather disappointing. Likewise the production of and later measurement of the discoloration by means of a reflecting color instrument has been beset with difficulties. An attempt, therefore, was made to standardize the conditions under which to perform a test of acceptable color of boiled potatoes. It is essential that representative samples can be taken and tests made within a few hours and in many localities by the inspectors in those areas.

Any subjective test is greatly improved by the use of a standard of comparison. Although the pictures used for this purpose should be as realistic as possible, any series of good range is beneficial in scoring since a standard base is available by which to compare numerous samples over long periods of time and in many localities.

It is suggested that a committee be chosen by potato growers' representatives interested in developing a standard subjective color

determination. Such a committee could decide upon the series of pictures to use as standard and to make copies available. Another contribution of such a committee would be to describe the procedure for representative sampling. The limits of acceptability for premium potatoes would need to be set in terms of scores, average scores and of range of color scores. It would be necessary to set a margin above that of mere acceptance to cover such conditions which might increase the discoloration before the consumer uses all the potatoes. Such conditionss include hardness of water and longer room temperature storage. The stringency of test must be such that only potatoes which can be assured to be of premium quality at any time before consumption should be so labeled.

Cooking and display conditions need to be specified. The experience in this laboratory, however, indicates that such procedures would not be difficult to prescribe. The following outline is suggested as a direction sheet for inspectors and their helpers.

Directions for Judging Potatoes for After-Cooking Darkening

I. Physical Arrangements.

1. This work should not be started unless an adequate physical plant is available. Cleanliness, neatness, and convenience are essential to the success of the operation. A conventional, modern, home-type kitchen would readily fulfill the requirements.
2. The essential equipment for this work are a sink with adequate drainage, a stove on which the heat can be controlled, a work area, and a display area with good illumination over it. A ceiling fluorescent lamp of approximately 80 to 100 wattage would suffice. A wide expanse of north light would be adequate on bright days but should the day be cloudy such light would be insufficient and adding incandescent lighting may give inaccurate results.
3. The selection of cooking pans. Aluminum, stainless steel, glass or heavy enamelware may be used, providing they are all alike. Enamelware must be discarded when chipping occurs because the exposed iron may increase the blackness of the potatoes. A common problem is that a black deposit is left in the pan if aluminum pans are used with water that contains iron. It is necessary that this deposit be removed either with available scouring pads or by boiling a solution of cream of tartar in the pan after each test. This would be true of any type of pan selected that discolored.
4. Cleanliness, and orderliness of the display are most important. White, semi-vitreous, China plates are excellent because the key can be written on them with a wax pencil, washed, and reused. A white, non-gloss shelf paper would also serve. The key or code identification could be written on it too, but it would have to be discarded after a single use.

II. Preliminary Preparations.

1. Keep varieties and samples separate throughout so they can be identified.

2. Record the code or key to the identity (number given to each sample) and do not refer to it until after the judging is completed.
3. Select medium sized potatoes.
4. Scrub with a brush under water.

III. Peeling and Cutting.

1. Peel with a hand potato peeler, being careful to go over an area only once so that an equal thickness of peel is removed over the entire potato. Remove eyes, bruises, blemishes, *etc.*, with the tip of a stainless steel paring knife.
2. Place potato on a cutting board flat side down. Cut through potato longitudinally so that one-half of the top and one-half of the bottom of the tuber are in each section.

IV. Boiling and Preparation for Judging.

1. Discard one-half of each and wash remaining halves and place in clean pans with closely fitted lids, keeping samples separate and labeled.
2. Add an equal weight of boiling tap water as you have potato sections; or enough to merely cover them. Bring back to boil as quickly as possible and then adjust heat in order to maintain the boiling temperature.
3. The degree of doneness is judged by piercing with a fork. It should readily enter but the section should still be intact. Potatoes which break up in cooking are almost impossible to use in judging blackness.
4. Drain immediately and cool.
5. Place each sample on white plates or white paper in a row; the cut side of the section down.
6. Expose to the air one-half hour before judging. The judging should be completed within two hours after removal from the heat.

V. Lighting, Judging and Recording.

1. The brightest light should not be facing the judge but both the sample and the pictures should be viewed with the light from the back but never in a shadow.
2. Judge the sections individually by holding the pictures near each section to get as good a match as possible. A range of 1 to 10 is possible, with 10 being the whitest and 1 the darkest potato as compared with the pictures and the scores underneath them. Yellow and green colors should be noted separately and only the amount of grayness or blackness considered in giving the numerical score. Within the range of 6 to 10, the pictures illustrate the fact that in some cases, the grayness may be less dense but cover the entire tubers whereas in others, there will be more marked light and very dark areas.
3. Have the potatoes scored by three to six judges, working individually, if at all possible, and especially for borderline cases. Discussion of the samples should follow the individuals' judging.
4. Consult the key or code for sample identity. Record the number of unacceptable potatoes and the average of the entire sample.

VI. Choice of Judges.

1. A good judge is any interested person who would come regularly and observe each tuber carefully—a housewife or Home Agent or Home Economics teacher.
2. The judges should have several practice periods to acquaint them with the range of possible discolorations in actual potatoes. The same judges should serve over a period of time since experience is of value.

Summary

It was found that darkening after cooking was increased by boiling susceptible potatoes in water of 24 grains hardness in contrast to softened water of 1 grain hardness. This difference in color of potatoes may be small, but must be considered in setting standards of quality for the consumer. It was learned that in some samples of potatoes, the amount of darkening was increased by three weeks of room temperature storage after removal from cold storage. This was not a factor to cause much variation in these samples of potatoes which scored good or very poor, but sometimes occurred on borderline cases. This also must be considered in setting limits of color quality acceptable in an inspection program.

Observations of discoloration and the assigning of scores is greatly aided by use of a series of photographs of wide range found in non-susceptible and susceptible potatoes. It is suggested that a grower-sponsord committee prepare such a standard and set limits of color quality for premium grade of potatoes.

NEWS AND REVIEWS

DR. WILLIAM BLACK, HONORED

It is a great privilege to me to be a participant on this unique occasion, when for the first time in the history of the Potato Association of America, a man from beyond the seas, is to be honored by Life Membership in this Association. Dr. William (Bill) Black is a man known to many of you personally and to all of you by reputation. I know that we all regret that Dr. Black is not able to be here with us tonight, but I think that this colored slide of Dr. Black, standing beside one of his own greenhouses in Scotland, will add a little personal touch to this occasion and will be of particular interest to those of you who have not had the opportunity of meeting him personally. (A colored slide of Dr. Black was projected on a screen at this point. Ed.)

Bill was born on September 1, 1903 on a farm in Scotland, his ancestors having been farmers as far back as can be traced. Life on the farm was full of interest and hard work, and as he once stated, with his inimitable droll humor, in order to avoid some of the hard work, he continued his education.

He attended Edinburgh University, graduating with a B.Sc. degree in Agriculture in 1925. During his student days, he qualified as a temporary inspector of potatoes for the Department of Agriculture for Scotland.

This seasonal work provided valuable experience and further stimulated his work on the potato.

After graduation, he was appointed "Assistant in charge of Potato Breeding" at this widely known plant breeding institution.

His work has been mainly concerned with research in the genetics of the potato, and with the breeding of new varieties. The breeding work has resulted in seven selections being registered as new varieties by the Department of Agriculture for Scotland. They are the Alness, Craig's Defiance, Craig's Royal, Craig's Snow White, Craig's Alliance, Pentland Ace and Pentland Beauty. In addition, Craigs van Riebeeck was named and approved in South Africa, while several unnamed blight resistant selections have been grown commercially in Tanganyika and Kenya.

It is for his research work that he is best known in this country. He has published about 30 papers, some of them under joint-authorship. He has been awarded, by the University of Edinburgh, the post-graduate degree of Doctor of Philosophy for his research dealing with "Genetical Studies in *Solanum tuberosum* L." and the degree of Doctor of Science for his studies on "The Inheritance of Resistance to *Phytophthora infestans* (Mont) de Bary in hybrid derivatives of *Solanum demissum* Lindl." Also for certain other publications, he was awarded the Makdougall-Brisbane Prize (1944-46) by the Royal Society of Edinburgh. In 1949, he was elected a Fellow of the Royal Society of Edinburgh.

It was during his visit to this country in 1953 that many of us became personally acquainted with Dr. Black, and it was during this same visit, that he received that highly coveted, but nevertheless award, the "Order of the Purple Top" for service behind a roto-beater in Wisconsin. (Dr. Black was injured slightly by a stone thrown from a roto-beater. Ed.)

I know that we were all greatly impressed by Dr. Black, not only as a research worker but also for those personal qualities that endeared him to a great many people in a relatively short time. It so happens that since that time I have had the very good fortune of spending three weeks, as a guest of the Blacks, in their home in Edinburgh. There, I renewed acquaintance with his charming wife, Isobel, who has that happy faculty of making strangers feel entirely at home almost immediately upon entering the door; a hostess who is continually thinking of your comfort, whether it is by putting hot water bottles in your bed in the early evening, or serving you with some very tempting Scottish dish, which you have not tasted before. While there, I met his fine family of two boys and two girls. There I partook of hospitality at its very best, and I really became acquainted with Dr. Black as a man. I found him to be a very kindly and an extremely modest individual, well-liked and highly thought of by all his associates, a man whom I don't believe ever said an unkind word about any one in his life. No matter where we went, people were glad to see him, and he was always received with a noticeable degree of respect, which I believe, is only meted out to one held in very high esteem, both as an individual and as a recognized authority in his chosen profession.

It is, therefore, with an especial degree of pleasure and a sense of real honor, that I present, *in absentia*, Dr. William Black, as a candidate for Honorary Life Membership in the Potato Association of America.

L. C. YOUNG, *Department of Agriculture, Fredericton, N. B., Canada.*

Dr. Reiner Bonde (center) accepting Honorary Life Membership Certificate from President Hougas at Annual Banquet of the Potato Association of America, Dec. 2, 1957. Paul Mosher (left) sponsored Dr. Bonde.

DR. REINER BONDE, HONORED

Reiner Bonde was born in Minneapolis, Minnesota and worked his way through high school and college. He graduated from Minnesota in 1922 with a B.S. Degree. While in college he held various positions: Assistant Plant Pathologist, USDA, Barberry Eradication work in 1919; worked on Grain Rust in Iowa and Minnesota 1920; Certified Seed Inspector for Minnesota; and was employed by the Nebraska Potato Improvement Association.

In 1924 he received a Master's Degree at the University of Maine and has been employed by the Maine Experiment Station since that date. He was Assistant Plant Pathologist from 1924 to 1928; Associate Plant Pathologist 1928 to 1947; and Plant Pathologist since 1947. A little time was taken in 1938 when he returned to Minnesota where he received his Doctor's Degree. His thesis was entitled "Insect Transmission of Bacterial Diseases in Potatoes."

Dr. Bonde is a past president of the Potato Association of America and has served on various committees of that organization. He is a member of American Phytopathological Society, American Botanical

Society, American Association for the Advancement of Science and the Potato Association of America. He is also a member of the Honor Society, Sigma Xi. In 1949 he received recognition by Maine Potato Growers for 25 years of outstanding service in potato research.

Dr. Bonde has worked on and found the solution to many potato production problems. He has worked on degenerative diseases—how they spread, their effect upon yields and of utmost importance, how to control them.

He was the first to describe and recognize bacterial wilt in Maine. Since then he has determined how it is spread, and found disinfectants to use on equipment to prevent its spread and has developed and tested thousands of wilt resistant varieties.

Dr. Bonde was one of the first to suggest isolated seed plots as a means of controlling both virus and bacterial diseases.

As a result of Dr. Bonde's work on virus and bacterial diseases the State of Maine Seed Board Farm was created to produce high quality seed for the Maine seed potato industry. His advice and counsel are a big factor in the production of 100 acres of top quality disease free seed on this farm.

He was the first to recognize that late blight spreads from cull piles under Maine conditions and developed materials and methods of controlling the disease. Hundreds of new fungicides have been tested in his plots for the control of this disease. Currently he is working on methods of forecasting late blight in Maine. Each year Dr. Bonde tests many seedlings for resistance to diseases especially late blight and bacterial wilt.

He has worked on seed treatment for the control of scab, and rhizoctonia and more recently on the use of antibiotics for the control of seed piece decay and soft rot. He has written over 140 scientific publications plus many popular articles for local use. These are only a few of Dr. Bonde's accomplishments.

It is very appropriate that Dr. Reiner Bonde should receive this Honorary Life Membership in the Potato Association of America—an honor he so richly deserves.

PAUL MOSHER, *Crop Specialist, University of Maine, Orono, Maine*

FREDERICK J. MEYER, HONORED

Frederick J. Meyer was brought up in West Salem, Wisconsin, and graduated from the University of Wisconsin in 1932. He majored in chemical engineering.

At the time of his graduation there were no jobs for a chemical engineer. His professor, Dr. Mathews, offered him an instructorship and urged him to continue studies toward a Doctor's degree. The university was paying \$70 to \$80 per month for instructors and this was about half as much as Fred had been making selling specialty foods (and especially potato chips) from the back seat of his car while attending school. Fred and his young wife decided to continue their own business.

This decision began a most fabulous career which, twenty-six years later, finds Frederick J. Meyer the president of a multi-million dollar corporation known as Red Dot Foods, Inc., Madison, Wisconsin.

Fred's interest in research has remained from university days through the years. As a member and president of the National Potato Chip Institute, he assumed a leading roll in the organization of the Research Department of that institution. For eight years, as a member of the Potato Commodity Committee appointed by the Secretary of Agriculture, he supported the many research projects in the agricultural field, especially the work with potato breeding and genetics. He has always been interested, too, in the

foreign potato introductions that are being maintained at Sturgeon Bay, Wisconsin. From the start he saw that it is a waste of time and money to introduce a lot of material unless it is studied cytologically and genetically and evaluated for its disease reactions so that it can be used to advantage by the potato breeders.

Although the recommendation of the committee was ignored for so many years, Fred never gave up. This was another obstacle to be overcome and by his talks and letters to certain key men in the U.S.D.A. he exerted a lot of influence in having funds appropriated for the Sturgeon Bay project.

In 1947, not satisfied with what was being done for the chip industry in the federal and state potato breeding programs, he organized the Red Dot potato breeding project. Over the years many named and seedling varieties were tested in cooperation with the U.S.D.A., the Wisconsin Agricultural Experiment Station and a number of other state experiment stations. As a result of these tests, a few varieties were found that have met the needs of the company to a greater extent than the old standard varieties. However, these have certain undesirable characteristics that make them far from ideal and the Red Dot potato breeding program has been continued and expanded.

Fred's business enterprises have grown from an investment of $22 in 1931 until in 1957 more than $10,000,000 worth of Red Dot products were sold throughout the Midwest.

The vanning department operates 28 tractor-trailer units to keep the eleven factories supplied with raw materials and the 100 branch warehouses supplied with merchandise. The sales branches put a total of 200 route trucks on the road every working day to service the more than 35,000 retail outlets of Red Dot products. To supervise all the sales and production activities, Red Dot's management team utilizes about 60 company cars and 2 airplanes. Almost 1000 employees comprise the growing Red Dot family.

Red Dot Farms cover 15,000 acres in Wisconsin and about 2,500 acres in Alabama, on which approximately 30 per cent of the potatoes needed to supply the many factories are raised. Over one-half million bushels of potatoes can be stored in air-controlled potato warehouses located close to potato growing land.

Through the many stages of development and rapid expansion, Fred and his wife have retained the ownership of Red Dot Foods, Inc. He is President; she is Secretary-Treasurer. They have two children, John, who is a senior at the University of Wisconsin and is on the Board of Directors of the company, and Carol who is attending the University of Colorado.

Fred is to be congratulated on his election to the exclusive fraternity of Honorary Life Members in the Potato Association of America and the Association is to be congratulated for electing a man that has helped to improve not only the art and science of making chips, but has promoted research in every other branch of the potato industry.

FREDERICK J. STEVENSON, *formerly Senior Geneticist, U.S.D.A., now in charge of potato breeding for Red Dot Foods, Inc.*

USDA'S POTATO ADVISORY COMMITTEE URGES INCREASED SUPPORT OF AGRICULTURAL RESEARCH

Greatly increased support of agricultural research in terms of scientist, equipment, facilities, and money was urged by the U. S. Department of Agriculture's Potato Research and Marketing Advisory Committee at its annual meeting held this year at Boise, Idaho, December 3-6.

The committee agreed that the present level of research support is not adequate, and that the Congress and the States should give priority to agricultural research programs and implement at once the long-term aim of expanding agricultural research stated in the Research and Marketing Act of 1946.

Short-term programs for surplus removal meet temporary emergencies, committee members observed, but do not bring a constructive solution to the agricultural problem over the long pull.

The committee listed, as important for potato growers and marketers, expanded research in post-harvest physiological changes in potatoes that cause losses or inferior quality, and strengthened fundamental studies of the effects of chemical changes on potato processing quality.

These studies, according to the committee, should include work on the nature of such storage disorders as internal blackspot, after-cooking darkening, and black heart. Such fundamental information is needed to develop methods of preventing these disorders.

The investigations of the effects of chemical changes on potato processing are necessary to provide a basis for developing ways of producing better potato products at lower cost, the committee said.

Established under the Research and Marketing Act of 1946, the committee is made up of leaders from the potato industry. Its detailed recommendations for research to be undertaken by USDA will be submitted formally to the Department within the next few weeks. Copies of this report will be available from the committee's executive secretary, Dr. Roy Magruder, Office of the Administrator, Agricultural Research Service, U. S. Department of Agriculture, Washington 25, D. C.

Other research proposals which the committee felt merit priority attention include:

1. Expanded work in breeding better potato varieties, resistant to insects and diseases and having better eating qualities as well as qualities that lend themselves to specific kinds of processing.

2. More research aimed at developing foreign markets for potatoes.

3. Expanded effort on the compiling of analytical data on composition and nutritive value of foods. These data are published as USDA's Food Composition Tables.

4. Strengthened work on improving marketing facilities by planning more wholesale facilities in specific localities to meet the current demand for this type of work.

5. A general expansion of all phases of potato marketing educational and service work.

Dr. James E. Kraus of Moscow, Idaho, Director of the Idaho Agricultural Experiment Station, was elected chairman of the committee, succeeding Frank W. Hussey of Presque Isle, Maine, executive vice-president of the Maine Potato Council. Loren Voth, H. H. Voth & Sons, Wasco, Calif., was named vice-president.

Other members who attended were: Edward H. Anderson, president, Edward H. Anderson & Co., Chicago, Ill.; Henry W. Bibus, Jr., grower, Chesterfield, N. J.; Bruce Gray, president, Florida Planters, Inc., Hastings, Fla.; R. W. Kohler, American Stores Co., Philadelphia, Pa.; Frederick J. Meyer, president, Red Dot Foods, Inc., Madison, Wis.; Ivan Miller, grower, Corry, Pa.; Ben Picha, grower, Grand Forks, N. D.; and Ted Still, grower, Monte Vista, Colo.

USDA RELEASES REPORT ON COST OF MARKETING CALIFORNIA LONG WHITE POTATOES

About 46 per cent of the retail price of a 100-pound bag of California Long White Potatoes sold in Los Angeles went to the grower during the 1955-'56 season, according to a report recently issued by the U. S. Department of Agriculture. For these potatoes sold in Chicago during the same period the grower received 35 per cent; for those sold in New York, 33 per cent.

This report is a part of a research program in the USDA's Agricultural Marketing Service designed to provide information on costs of marketing food. Some of the findings from this study of marketing costs for California Long White potatoes retailed in three cities were as follows: The average retail price for a 100-pound bag of potatoes in Los Angeles was $9.81. Of this retail price, the grower received about $4.50, and the total cost of shipping, packing, storing, wholesaling, and retailing was $5.31.

When California potatoes were sold in Chicago and New York the picture was considerably different. The average retail price in Chicago during the same period was $10.27, of which the grower got $3.56, leaving $6.71 as the cost of marketing. The respective figures for New York City were $11.38, $3.72, and $7.66.

Average costs of various services for marketing a 100-pound bag of California Long White potatoes sold in Los Angeles, Chicago, and New York City look like this: Transportation charges $0.32 to Los Angeles (truck), $1.83 to Chicago (rail), and $2.28 to New York City (rail). Wholesale margin—$0.25 in Los Angeles, $1.11 in Chicago, and $1.76 in New York City. Retail margin—$4.08 in Los Angeles, $3.11 in Chicago, and $2.96 in New York City. Packing costs were 66 cents for all potatoes.

A free copy of this report, "California Long White Potatoes Sold in Los Angeles, Chicago, and New York City During the 1956 Season"—Marketing Research Report No. 193— may be obtained from the Office of Information, U. S. Department of Agriculture, Washington 25, D. C.

BOOK REVIEW

Braun und Riehm. 1957. Krankheiten und Schadlinge der Kulturpflanzen und ihre Bekampfung. 8 Aufiage. Paul Parey in Berlin und Hamburg. 368 pp. Price DM 29,80.

This 368 page, eighth revised edition, is a well organized, highly instructive discussion of diseases, insect pests and other ailments that affect various important cultivated crops grown in central Europe. The book is divided into two major parts. A 30-page "General Part" gives a brief but very instructive general discussion of the cause, progress, economic importance and control of plant troubles as a whole. A much more extensive "Special Part", divided into 22 sections, deals largely with troubles affecting specific crops. Twenty-one of these are devoted to the following individual crops or crop groups: grains, potatoes, beets, carrots, beans and peas, cole crops, tomatoes, onions, asparagus, cucumbers, rape and related crops, flax, poppy, tobacco, hops, tree and bush fruits, and grapes. A final section deals with insects, diseases and other troubles that are common to a number of crops.

The material presented in each of the special sections is arranged in the same order. Each starts with a brief and very workable KEY to the various diseases or ailments discussed. The key, based largely on the parts of the plant affected and the characteristic symptoms shown by the plant or plant part, helps materially in diagnosing the specific plant problem of immediate interest to the reader. The rest of the section is devoted to a description of each of the major diseases, insect pests and other ailments affecting the crop, together with a discussion of the causal agent and suggestions for control.

The book has 346 excellent illustrations, mostly photographs showing symptoms or insects causing the trouble.

For readers who wish more information on specific topics than can be given in a small book dealing with such an extensive subject, there are numerous references cited, mostly from German sources.

A ten-page subject index and the systematic arrangement of the book on a crop basis makes any desired information readily located without laborious searching from page to page.

The book should prove very useful for anyone interested in diseases, insect pests, and other ailments of the specific crop plants included.

C. M. Haenseler, *Plant Pathologist, Rutgers University, New Brunswick, N. J.*

TARPAULIN COSTS CUT BY NEW METHOD

A new method allowing the worker on the job to install any size tarpaulin from a large continuous roll was just announced by Herculite Protective Fabrics.

Eliminating almost seventy-five per cent of the usual fabrication cost for hemming and grommeting tarpaulins, this method guarantees a stronger tie-down to resist wind forces.

The method calls for penknife slits to be placed along the edge of the fabric and positioned wherever a tie-down is desired.

This new technique is made possible through an exclusive process that permanently locks vinyl plastic to nylon fibers resulting in a tarp fabric with such tremendous resistance to tearing that slits cut in the manner described will not spread, and edges will not ravel. A variety of tough industrial nylon tarp fabrics are available in roll widths up to 20 feet and can be provided up to 100 feet wide.

"This development," states Mr. Sy Hyman, President of Herculite, "is our most significant contribution made to reduce costs for protective coverings. Now, a single roll 20 feet wide can be cut to yield tarpaulins of all common sizes, thus reducing extensive inventory requirements. Dramatic changes will be seen in future buying habits and marketing procedures."

For many years, Herculite, pioneering high strength, light weight, rot proof, coated synthetic industrial textiles, has been serving such diversified markets as maritime, construction, trucking, agriculture, *etc.*

For additional information, write: Herculite Protective Fabrics, Belleville 9, New Jersey.

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The Brown Shoveler does the job of six manual shovelers. The wide-mouth vibrator receiving hopper WALKS gently but firmly into produce pile, eliminates many bruises caused by hand shoveling and automatically conveys produce up and on to either grading hopper, bulk loader or directly into container.

The Brown Vibrator action and overall functional construction hopper is controlled by a quick release clutch system. The durable, Neoprene conveyor belting is cleated to insure an even, continuous flow of produce. The shoveler works on any floor surface and no spread troughs are needed. A wide-mouth receiving hopper-end provides ample working area before moving unit to other areas. Special design insures unit will always be on pile bottom and never "climb-up". Bruising is minimized.

The new Brown Automatic Shoveler is built with pressed steel. Construction features include: Roller and sealed bearings, lagged drive roller, direct chain drive off enclosed gear head motor, heavy duty electrical equipment, adjustable discharge apron, adjustable chute and balloon tires. The entire unit is balanced for simple and easy portability.

For additional information, prices, specifications write to K. G. Brown Manufacturing Co., Inc., Mattituck, Long Island, N. Y.
